War Gases in a Nutshell

By THE KERNEL

HISTORY records numerous abortive attempts to utilize chemical substances as war weapons, but it is not within the scope of this article to go into such occurrences prior to the Great War, except to mention that with the exception of "Greek Fire," none of them produced important results nor challenged the supremacy of existing weapons. The first toxic gases used in the Great War were the lachrymators—substances having a specific action on the eyes and producing a copious flow of tears and temporary blindness. It is difficult to attach the blame for the first use of toxic gases during the Great War, for the effects of the lachrymators were so transitory that no one at the time regarded them as coming within the meaning of the agreement of the Hague Conventions, 1899 and 1907.

In the low concentrations met with in the open, lachrymation was the only effect produced. However, when used against enclosed places, such as field fortifications, deep trenches, and dug-outs, toxic concentrations could accumulate and serious casualties result.

The first gas used in the War was "ethylbromacetate," and was used by the French in August, 1914. The success attained by the French police in suppressing lawless gangs with this gas undoubtedly led to its adoption by the French Army as a filling for 26 mm. rifle grenades.

The great advantage of the lachrymators is the extremely low concentration required to necessitate wearing of the respirator, they are also useful for masking the presence of other toxic gases.

It was noted early in the War that concentrations of the lachrymators which caused profuse lachrymation in men produced no visible effect upon horses or mules. The reason has never been explained, although the fact is well established by tests and war experience.

The three principal tear gases are :—

1. Chloracetophenone—C.A.P. solid and non-persistent.
2. Ethyliodoacetate—K.S.K. liquid and persistent.
3. Bromo-benzyl-cyanide—B.B.C. liquid and persistent.

All produce their effects on the eyes only, and in low concentrations likely to be met with in the open.

The symptoms disappear on removing the victim from the gas area, and they can be relieved by irrigation of the nose and conjunctivæ with warm saline solution or even warm water. The respirator gives complete protection against these gases.

Nose-Irritants or Sternutators.

By the summer of 1917 the respirators of all the belligerents had improved to a stage where they furnished adequate protection against the lung irritants. Also the lung-irritant gases were slow-acting and did not incapacitate until several hours after exposure.

The problem was to find a quick-acting non-persistent gas that would penetrate the respirator then in use, and the nose-irritants were the solution of the German chemists to this problem. When used in the last War, the enemy's object was to penetrate the respirator then in use and cause it to be discarded, thereby exposing the victim to a deadly gas such as phosgene, which was released simultaneously. All the modern respirators will give adequate protection against these gases.

Lung Irritants.

The lung irritants were the next group of gases to make their appearance in the War, in the famous chlorine cloud attack by the Germans on the French and British Colonial troops in the trenches around Ypres, April 22nd—24th, 1915. The casualties amounted to fifteen thousand, of which five thousand were fatal. The master-mind behind this new method of warfare was Professor Haber—a civilian and a Jew. These two disabilities so prejudiced the minds of the German General Staff against his project that it was only after great opposition it was given a trial. German Headquarters distrusted poisonous gas so much that no measures were taken to follow up its possible success.

The most important members of the lung irritant group are :—Chlorine, phosgene, diphosgene, and chloropicrin.

Their principal action is injury to the trachea, bronchi, and lungs, and the result of this injury is to cause fluid to pass from the blood into the air-cells of the lungs and thus obstruct the oxygen supply to the blood.

Their action may be compared to death by drowning, the fluid in which the victim drowns being drawn into his lungs from his blood-vessels.

All the lung irritants cause the same type of pathological effect, the great danger being the onset of acute pulmonary œdema.

In chlorine and chloropicrin poisoning the trachea and bronchi show serious damage. A marked feature in chlorine and chloropicrin poisoning is painful dyspnœa, paroxysmal cough accompanied by vomiting, which occurs during exposure and persists for a long time afterwards.

Phosgene exerts its physiological and toxic effects through its hydrolisis products — viz., H.C.L. and CO_2. Unlike chlorine, phosgene causes slight irritation of the nerves in the upper air-passages, owing to the amount of moisture there being small. With prolonged breathing, sufficient phosgene is decomposed in the trachea and bronchi to produce marked inflammation and erosion.

These effects reach their maximum in the alveoli of the lungs, where the air is saturated with moisture.

Phosgene is very insidious in its action, and victims gassed with it often have no warning symptoms until too late to avoid serious poisoning.

Generally the victim first experiences a temporary weak spell, but otherwise feels well and has a good appetite; suddenly he grows worse, and death frequently follows in a few days from pulmonary œdema, etc.

Phosgene is about ten times more toxic than chlorine, and since it has the odour of musty hay is not so easily detected.

The symptoms of poisoning by phosgene only are mentioned, as the use of the

other gases of the lung irritant group in warfare is considered unlikely. Depending on the concentration and length of exposure, symptoms may be—acute with violent onset, or acute with insidious onset. In the latter case the victim may be able to carry on his work, etc., for some hours with only trivial discomfort, and then suddenly collapse. Apart from cases in which death occurs within two to three hours after exposure, lung casualties may be divided into three types :—

1. The *mild case* with flushed face, rapid respiration, and painful cough.
2. *Severe case* with marked cyanosis, distended neck veins and rapid breathing, full strong pulse, cough and expectoration of large quantities of frothy sputum. This is known as the "blue type."
3. The collapsed type with ashen pallor, leaden coloured lips, and general collapse. Pulse rapid, weak, and irregular, pointing to cardiac dilatation. This is known as the "grey type" with marked circulatory collapse. These cases are even more asphyxiated than those with the plum-coloured cyanosis and in greater need of oxygen treatment.

In the early acute stage the physical signs give little indication of the gravity of the case or the extent of damage to the lungs.

The colour, pulse, character of the respirations, and the mental condition of the victim are the chief guide to prognosis.

Treatment in the acute stage comprises :—Rest, warmth, venesection, and oxygen.

The respirator gives complete protection against any concentration of lung irritants likely to be encountered.

Blister Gases or Vesicants.

Mustard-gas was first used by the Germans on the night of 12th July, 1917, at Ypres in Flanders, in an artillery bombardment against the British troops.

The vapours arising from the bursting shells had no immediate irritating action on the eyes or lungs, and the troops at first suffered no immediate discomfort from gas except irritation of the nose, which caused sneezing, etc. In the course of a couple of hours the signs of mustard-gas poisoning began to appear in the form of inflammation of the eyes and vomiting, followed by erythema of the skin and blistering.

Altogether about 12,000 tons of mustard-gas were used in the War and caused a total of 400,000 casualties.

Mustard-gas proved to be not only the best defensive gas, but the best all-round casualty producer used in the Great War.

In its pure state mustard is a transparent amber oily liquid, but in the crude form in which it is usually used it resembles dirty oil from a motor engine. It is almost odourless in ordinary field concentration, and in strong concentrations resembles horse-radish or garlic. The sense of smell becomes quickly dulled to the vapour, and the gas is consequently very insidious and dangerous in weak concentrations. It is one of the most persistent gases known and is very difficult to destroy.

The respirator only protects the eyes and respiratory passages from the vapour, leaving the other parts of the body vulnerable.

Mustard-gas will produce casualties from the vapour and from the liquid.

The main features of casualties from mustard vapour are :—

1. Insidious onset with delay of obvious effects varying from two to forty-eight hours.
2. Phinitis resembling a severe "cold" in the head.
3. Conjunctivitis of varying degree.
4. Brassy cough, laryngitis, hoarseness and ophonia, appearing about the same time as the conjunctivitis.
5. Nausea, vomiting, and epigastric pain, due to swallowing of the saliva or nasal secretions impregnated with the gas.
6. Inflammation of the trachea or bronchi with subsequent bronchitis or broncho-pneumonia.
7. Erythema of exposed surfaces and of moist protected skin areas followed by blistering.

From the point of view of mortality and lasting after-effects, it is injury to the trachea and lungs that is the most important feature of mustard-gas poisoning.

The effects are the result, not of the actual gas, but of the secondary bacterial invasion which follows.

The effects of the liquid are observed on the skin and in the eye.

On the skin redness appears at the site of contact in a couple of hours and is accompanied by itching.

Later the skin becomes congested and œdematous, and within twelve to twenty-four hours a blister filled with clear yellow serum which contains no actual mustard-gas forms.

Injury may result to the eye from splash or spray, and permanent damage will result. This is the only occasion on which mustard advertises its presence by immediate irritation, as stinging of the eye results on contact. This passes off and symptoms will return in half an hour and progress rapidly.

Damage may vary from a simple burn to complete destruction of the eye.

Treatment.

Blisters should be opened and the condition treated as an ordinary thermal burn. The eyes should be frequently irrigated as soon as possible. In liquid contamination immediate action is essential, and even then the best that can be hoped for is mitigation of the damage.

The most important treatment is preventive measures, and in case of vapour contamination consists in rapid removal of clothing and thorough washing of the body with soap and water. The eyes should be irrigated in all cases with warm water or saline.

For liquid contamination three forms of treatment are available, viz :—

1. *Bleach treatment*—by ointment or paste which neutralises the mustard-gas.
2. *Treatment by a solvent*—such as petrol or kerosene. By this method the

mustard-gas is not destroyed but only dissolved, and care must be taken not to spread the contamination by allowing the solvent to run. Thorough washing with soap and water will complete the treatment.

3. *Thorough washing with soap and water.*—If some time has elapsed after contamination, the washing treatment should still be carried out at the first opportunity with the hopes of mitigating the degree of burning.

Bleach ointment or paste should never be applied to a skin already showing signs of irritation, as it aggravates the condition.

Speed is the essence of all preventive treatment, and a delay of *three minutes* with liquid contamination or twenty minutes following exposure to vapour before cleansing the skin is carried out will result in definite burns.

The other important blister gas—Lewisite—is a vesicant compound containing arsenic, and is America's principal contribution to the war gases. It was not used during the Great War, but twenty thousand tons of it were on the way to Europe when the Armistice was signed, and it was destroyed at sea.

It is an oily liquid, colourless in the pure state, but darkening on standing. Pure Lewisite is odourless, but on contact with moisture or in the impure form it smells strongly of geraniums.

Lewisite is more rapid than mustard in its action, producing more discomfort when breathed and more irritation when placed on the skin.

It lacks the insidious character of mustard-gas, and its extreme pungency and penetrative odour renders it early of detection when similar concentraitons of mustard-gas would not be noticed.

Broadly speaking, its effects on the body are similar to mustard.

Lewisite can be neutralised by water, especially if it is hot and contains an alkali. So that preventive treatment consists essentially in rapid removal of clothing followed by washing in soap and water.

Lewisite can also be neutralised by a five per cent. aqueous solution of sodium hydroxide or removed by solvents or destroyed by bleach.

REVIEWS

THE DYSENTERIC DISORDERS. By Philip Manson-Bahr, C.M.G., D.S.O., M.D., F.R.C.P. 1939. London. Cassell & Co., Ltd. Pp. xiv + 613. Figs. 106. Plates 25. 25s. net.

In the study of the bacillary, protozoal, and helminthic dysenteries much advance has recently been made. Many expert workers have studied the causal organisms and their often complicated life-cycle. Treatment based on exact diagnosis has in some forms been highly successful. Much of the relevant literature is scattered and often inaccessible. There are few conditions in tropical medicine which have as many points of contact with the diseases of more temperate climates as the dysenteries and related disorders, the infective diarrhœas, steatorrhœas, and the various forms of colitis. This conveniently sized and excellently produced volume is especially valuable. The author has